**REQUEST FORM FOR CONTINUATION/DIVISION APPLICATION UNDER 37 CFR 1.53(b)**

Docket No. SON-1450/DIV
File No.
Anticipated Classification of this application:
Class * Subclass *
Prior Application:
Examiner T. Weingart
Group Art Unit 1763

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This is a request for filing a divisional application, under 37 CFR 1.53(b) of pending prior application Serial No. 08/739,101 filed on October 25, 1996 of Junichi SATO entitled CHEMICAL-MECHANICAL POLISHING PROCESS.

1. ☒ Enclosed is a true copy of prior application Serial No. 08/739,101 including the Declaration and Power of Attorney, as originally filed on October 25, 1996.

2. ☐ A _____ was submitted in the prior application on _____, a copy of which is enclosed.

3a. ☒ The filing fee is calculated below:

| CLAIMS AS FILED IN THE PRIOR APPLICATION, PLUS OR MINUS ANY CLAIMS ADDED OR CANCELLED BY AMENDMENT BELOW | | | | | | |
|---|---|---|---|---|---|---|
| | NUMBER FILED | | (4) HIGHEST NO. PREVIOUSLY PAID FOR | (5) NUMBER EXTRA | RATE | BASIC FILING FEE $790/$395 |
| Total Claims | 8 | Minus | **20 | = 0 | x $11° $22 | $0 |
| Indep. Claims | 2 | Minus | ***3 | = 0 | x $41° $82 | $0 |
| Fee for Multiple Dependent Claims | | | | | $135° $270 | |
| | | | TOTAL ADDITIONAL FEE FOR THIS AMENDMENT | | | $790.00 |

3b. ☐ The present application is filed by a small entity (37 C.F.R. § 1.9(f)). A Verified Statement claiming small entity status was filed in the prior application.

3c. ☒ Any prior general authorization to charge an issue fee under 37 C.F.R. 1.18 to Deposit Account No. 18-0013 is hereby revoked. The Commissioner is hereby authorized to charge any fees which may be required during the entire pendency of this application under 37 CFR 1.16 and 1.17, or to credit any overpayment, to Deposit Account No. 18-0013. A duplicate copy of this sheet is enclosed.

4a. ☒ Charge $ 790.00 to Deposit Account No. 18-0013. A duplicate copy of this sheet is enclosed.

5. ☒ Cancel in this application original claims 1 to 11 and 15 of the prior application before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

6. ☒ Amend the specification by inserting before the first line the sentence: --This application is a divisional of application Serial No. 08/739,101 filed October 25, 1996.

7a. ☐ Transfer the drawings from the prior application to this application and abandon said prior application as of the filing date accorded this application. A duplicate copy of this sheet is enclosed for filing in the prior application file.

7b. ☒ New ☒ formal ☐ informal drawings are enclosed.

8a. ☒ Priority of the following application(s) is claimed under 35 U.S.C. § 119:

| Country | Application No. | Filed (Mo., Day & Yr.) |
|---|---|---|
| JAPAN | P07-321005 | November 14, 1995 |

8b. ☒ The certified copy of the priority application(s) has been filed in prior U.S. Application Serial No. _____, filed _____.

9. ☒ The prior application is assigned of record to:

SONY CORPORATION

10. ☒ The power of attorney in the prior application is to:

Richard Linn, Registration No. 25,144; Paul Devinsky, Registration No. 28,553; Ronald P. Kananen, Registration No. 24,104; Albert J. Zervas, Registration No. P-33,822; Michael D. Bednarek, Registration No. 32,329; James G. Gatto, Registration No. 32,694; Allen W. Wark, Registration No. 30,503.

11a. ☒ The power appears in the original papers in prior application Serial No. 08/739,101.

11b. ☐ Since the power does not appear in the original papers, a copy of the power in prior application Serial No. _____ is enclosed.

11c. ☒ Recognize as Associate Attorneys:

Ralph T. Rader, Registration No. 28,772; Michael D. Fishman, Registration No. 31,952; Richard D. Grauer, Registration No. 22,388; Joseph V. Coppola, Sr., Registration No. 33,373; Michael B. Stewart, Registration No. 36,018; Jeffrey L. Thompson, Registration No. 37,025; Steven L. Nichols, Registration No. 40,326; David K. Benson, Registration No. 42,314; and Kyle J. Choi, Registration No. 41,480.

11d. ☒ Applicant's undersigned attorney may be reached by telephone in our Washington D.C. Office at

(202) 955-3750

11e. ☒ Address all future communications to:

Ronald P. Kananen
Rader, Fishman & Grauer PLLC
1223 20th Street, N.W.
Suite 501
Washington, D.C. 20036

12a. ☒ A preliminary amendment is enclosed. (Claims added by this amendment have been properly numbered consecutively beginning with the number next following the highest numbered original claim.)

12b. ☐ The applicant(s) presently intend(s) to file additional papers in this case after receiving an official Filing Receipt. Should the Examiner take this case up for action before receiving such papers, it is respectfully requested that the Examiner contact the attorneys for the applicant(s) at the telephone number shown above.

Dated: September 29, 1998

Ronald P. Kananen
Attorney for Applicant(s)
Registration No. 24,104

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jc408 U.S. PTO 09/29/98

# UTILITY PATENT APPLICATION TRANSMITTAL

*(Only for new nonprovisional applications under 37 CFR 1.53(b))*

| | | | |
|---|---|---|---|
| *Attorney Docket No.* | SON-1450/DIV | *Total Pages* | |
| *First Named Inventor or Application Identifier* | Junichi SATO | | |
| *Express Mail Label No.* | | | |

jc525 U.S. PTO 09/161620 09/29/98

## APPLICATION ELEMENTS

*See MPEP Chapter 600 concerning utility patent application contents*

*ADDRESS TO:* **Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231**

1. [X] Fee Transmittal Form *(Submit an original, and a duplicate for fee processing)*
2. [X] Specification *[Total Pages 20 ]* *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R&D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 USC d113)* *[Total Sheets 3 ]*
4. Oath or Declaration *[Total Pages 2 ]*
   - a. [ ] Newly Executed (original or copy)
   - b. [X] Copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 17 completed)*

   ***[Note Box 5 below]***

   - i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(2) and 1.33(b).
5. [ ] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy
   - b. [ ] Paper Copy (identical to computer copy)
   - c. [ ] Statement verifying identical of above copies

## ACCOMPANYING APPLICATION PARTS

8. [X] Assignment Papers (cover sheet & Documents(s))
9. [ ] 37 CFR 3.27(B) Statement *(when there is an assignee)* [ ] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [X] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] Small Entity Statement(s) [ ] Statement filed in prior application Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *if foreign priority is claimed)*
16. [ ] Other

**17. If a CONTINUING APPLICATION,** *check appropriate box and supply the requisite information*

☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application No: 08/739,101

## 18. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* or [X] *Correspondence address below*

| | | | | | |
|---|---|---|---|---|---|
| *NAME* | **Ronald P. Kananen Reg. No. 24,104** | | | | |
| *ADDRESS* | **Suite 501, 1233 20th Street, NW** | | | | |
| *CITY* | Washington | *STATE* | DC | *ZIP CODE* | 20036 |
| *COUNTRY* | United States of America | *PHONE* | (202) 955-3750 | *FAX* | (202) 955-3751 |

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In the Divisional Patent Application of

Junichi SATO

Serial No. Not Assigned

Filed: **Herewith**

For: CHEMICAL-MECHANICAL POLISHING PROCESS

Group Art Unit: 1763

Examiner: T. Weingart

**PRELIMINARY AMENDMENT**

Assistant Commissioner of Patents
Washington, DC 20231

Sir:

Prior to an initial examination on the merits, please amend the above-identified continuation application as follows:

IN THE SPECIFICATION:

On page 1, line 15, delete "to".

On page 2, line 7, delete "more".

On page 5, line 3, insert -- . -- following "sialon"; lines 15 to 16, change "the use of silica base slurry has a difficulty in more increasing a polishing rate" to -- it is difficult to increase the polishing rate when using a silica base slurry --.

On page 13, line 14, change "was" to -- were --.

On page 14, line 4, change "in" to -- at --; line 9,

change "become" to -- became --; line 13, insert "the" before "thin"; line 14, change "are" to -- were --; line 18, delete "very".

IN THE CLAIMS:

Please cancel claims 1 to 11, and 15.

12. (amended) A chemical-mechanical polishing process for planarizing [at least] one or more [of thin] films formed on a substrate, wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles [mainly made of] containing boehmite.

13. (unchanged) A chemical-mechanical polishing process according to claim 12, wherein the particles of boehmite are formed by dipping of particles of Al in hot water.

14. (unchanged) A chemical-mechanical polishing process according to claim 13, wherein said hot water is added with sodium aluminate.

16. (amended) A chemical-mechanical polishing process for planarizing [at least] one or more [of thin] films formed on a substrate, wherein said thin films are subjected to chemical-mechanical polishing using a slurry containing

abrasive particles [mainly made of] containing boehmite, and the residual slurry and contamination are removed by spin cleaning.

17. (amended) A chemical-mechanical polishing process according to claim 16, wherein said spin cleaning is performed using chemicals comprising [$NH_4$-$H_2O$-$H_2O$ and dilute] a solution containing NH4, H2O2, and H2O, followed by a hydrofluoric acid solution.

18. (unchanged) A chemical-mechanical polishing process according to claim 17, wherein after spin cleaning using said chemicals, said substrate is rinsed with pure water.

19. (unchanged) A chemical-mechanical polishing process according to claim 16, wherein the abrasive particles of boehmite are formed by dipping of particles of Al in a hot water.

20. (unchanged) A chemical-mechanical polishing process according to claim 19, wherein said hot water is added with sodium aluminate.

**REMARKS**

Prior to an initial examination of the above-identified continuation application, please enter the foregoing amendment. Claims 1 to 11 and 15 are canceled as they have been allowed in pending Patent Application No. 08/739,101. Accordingly, claims 12 to 14, and 16 to 20 are pending for the Examiner's consideration. It is pointed out that allowed claim 15 was considered by the Examiner to be generic to the species claimed in the above claims.

Respectfully submitted,

DATE: 29 September 1998

Ronald P. Kananen
Registration No. 24,104

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# CHEMICAL-MECHANICAL POLISHING PROCESS

## BACKGROUND OF THE INVENTION

The present invention relates to a chemical-mechanical polishing process, and particularly to a chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate (wafer). The present invention is suitable for forming multilayers of interconnections in a process of fabricating semiconductor devices, particularly, for planarizing interlayer dielectric films or forming metal plugs at high reliability. More specifically, the present invention is suitable for forming multilayers of interconnection used for memory elements or logic operation elements having highly fine and highly integrated structures.

The interconnection technology is increasingly toward to finer geometries and multilayers of interconnections along with high density mounting for devices. The technology for forming multilayers of interconnections comes to play a larger role in a process of fabricating semiconductor integrated circuits. On the other hand, the multilayers of interconnections bring about a new disadvantage.

More specifically, steps of interlayer dielectric films become larger and steeper along with a tendency toward fine geometries and multilayers of interconnections, to thereby cause degradation both in processing accuracy and in reliability of an interconnection formed on the interlayer dielectric films having such steps.

At the present time, it is difficult to more improve step coverage of an Al interconnection, and accordingly, the planarity of interlayer dielectric films must be improved for ensuring the processing accuracy and reliability of the above interconnection.

The improvement in planarity of interlayer dielectric films also becomes important because it compensates for a reduction in focal depth with the shortened wavelength of light in lithography. In other words, the improved planarity of interlayer dielectric films makes it possible to keep the resolution already reaching the critical value.

Various technologies for forming dielectric films and planarizing them have been developed. However, when applied to multilayers of interconnections having finer geometries, they present vital disadvantages in terms of shortage of planarity in the case of wide gaps between

interconnections and in terms of connection failure between interconnections due to spaces generated in interlayer films in gaps between interconnections.

To improve such disadvantages, a chemical-mechanical polishing process (CMP) for global planarization of interlayer dielectric films has been recently carried out or examined. This process has been originally used for mirror-like polishing for a silicon substrate.

The chemical-mechanical polishing process is expected to positively planarize the entire surface of an interlayer dielectric film. In this process, a polishing cloth is placed on a polishing plate and the polishing plate is rotated while slurry is supplied on the polishing cloth. At the same time, a substrate disposed on a carrier is rotated and pressed on the polishing cloth, to thus polish a dielectric film formed on the surface of the substrate. At this time, KOH or the like is added to the slurry for etching the dielectric film in a basic atmosphere.

In the practical use, cleaning is performed after chemical-mechanical polishing for sufficiently removing the residual slurry and the like, thus completing the planarization.

This process, however, has a disadvantage in processing speed, that is, polishing rate. Specifically, the polishing is as low as about 100 nm/min. This is inconvenient for the future chemical-mechanical process in terms of the increased cost due to poor productivity.

In recent years, one approach using a cerium base slurry, that is, a slurry containing particles of cerium oxide has been proposed. This is expected to obtain a polishing rate being 3 to 4 times that in the case of using a related art silica base slurry. The cerium base slurry, on the other hand, presents a problem in poor planarity of the processed surface and in poor level of metal impurities, and therefore, it actually fails to exhibit the expected result.



OBJECT AND SUMMARY OF THE INVENTION

An object of the present invention is to provide a chemical-mechanical process capable of improving a polishing rate without degradation in planarity of the processed surface and in level of metal impurities.

To achieve the above object, the present invention provides a chemical-mechanical process for planarizing at least one or more of thin films formed on a substrate,

wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of sialon

The present invention also provides a chemical-mechanical process for planarizing at least one or more of thin films formed on a substrate, wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of boehmite.

In the related art process, silica base abrasive particles are used. On the other hand, a thin film formed on a substrate is generally made of $SiO_2$. Accordingly, the polishing of the thin film made of $SiO_2$ using the silica base slurry means that $SiO_2$ is polished using $SiO_2$, that is, a material is polished using the same material. As a result, the use of the silica base slurry has a difficulty in more increasing a polishing rate for the thin film made of $SiO_2$ by the physical action.

In the present invention, chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of sialon or boehmite. Sialon or boehmite is higher in hardness than $SiO_2$. Accordingly, the chemical-mechanical polishing process using the slurry containing abrasive particles mainly made of such a

material accelerates the polishing not only by the chemical action but also by the physical action.

As a result, the chemical-mechanical polishing process of the present invention using the slurry containing abrasive particles mainly made of sialon or boehmite increases a polishing rate more than that obtained in the related art chemical-mechanical process. Furthermore, in reactive ion etching, ion bombardment action in addition to chemical action of radicals can increase the etching rate.



BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a sectional view of an element used in Examples 1, 3 of the present invention, in which interlayer dielectric films and an interconnection are formed on a substrate;

Fig. 1B is a schematic sectional view of the element shown in Fig. 1A, showing the state after the interlayer dielectric film is subjected to chemical-mechanical polishing of the present invention using a slurry containing abrasive particles mainly made of sialon or boehmite;

Fig. 2A is a schematic view of an element used in

Example 2 of the present invention, in which interlayer dielectric films, an interconnection, and blanket tungsten are formed on a substrate;

Fig. 2B is a schematic sectional view of the element shown in Fig. 2A, showing the state after the blanket tungsten is subjected to chemical-mechanical polishing using a slurry containing abrasive particles mainly made of sialon; and

Fig. 3 is a schematic front view of a chemical-mechanical polishing apparatus used for carrying out the present invention.



## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, the present invention will be described in detail with reference to the accompanying drawings. Fig. 3 is a schematic view of a chemical-mechanical polishing apparatus for carrying out the present invention. A polishing plate 3 called a platen is rotated around a shaft 4. A polishing cloth 9 called a pad is attached on the polishing plate 3, and a slurry feed unit 10 is disposed over the polishing cloth 9. A slurry 2, which is stored in the slurry feed unit 10, is fed on the polishing cloth 9 through a slurry feed port 1.

On the other hand, a carrier 6 mounting a substrate 5 is rotated around a shaft 7. The substrate 5 is rotated together with the carrier 6 and is pressed on the polishing plate 3. The rotational speeds of the polishing plate 3 and the carrier 6, the pressure of a polishing pressure adjuster 8, and the feed amount of the slurry 2 are suitably adjusted. In addition, the above description is for illustrative purposes only, and it is to be understood that the attachment of the substrate, the number and the configuration of each of the platen and the carrier, and the structure of the pad may be changed.

Examples of the present invention will be described below.

Example 1

In this example, an interlayer dielectric film formed on an Al interconnection layer is subjected to chemical-mechanical polishing using abrasive particles mainly made of sialon. As shown in Fig. 1A, a first interlayer dielectric film 102 made of silicon oxide and an Al interconnection layer 103 were formed on a semiconductor substrate 101 made of silicon, and a second interlayer dielectric film 104 was formed thereon. In addition, these

were all formed by known processes.

The second interlayer film 104 was then subjected to chemical-mechanical polishing under the following condition using a polishing apparatus shown in Fig. 3.

| | |
|---|---|
| rotational speed of polishing plate: | 50 rpm |
| rotational speed of carrier | : 17 rpm |
| polishing pressure | : 8 psi |
| temperature of polishing pad | : 30-40℃ |
| flow rate of slurry | : 225 ml/min |

The above polishing condition is that generally used for dielectric films. Here, for the purpose of polishing in a basic atmosphere, a suspension in which a slurry containing abrasive particles mainly made of sialon was suspended in a solution of KOH/water/alcohol, was used as a polishing agent. The abrasive particles of sialon was formed from a gas system containing $SiH_4$, $N_2$, $O_2$, $Al(CH_3)_3$ by plasma CVD in such a condition that fine particles could be formed through nuclei growth in a uniform vapor-phase.

As a result, the second interlayer dielectric film 104 was planarized, as shown in Fig. 1B. Next, the residual slurry and contamination on the surface of the

substrate were removed by a spin cleaner using chemicals of $NH_4OH$-$H_2O_2$-$H_2O$ and dilute hydrofluoric acid in this order, and finally, the surface of the substrate was rinsed with pure water. The residual slurry and contamination were thus removed in a satisfactory level. In particular, although contamination due to aluminum as a component of sialon was a matter of concern, it was sufficiently removed by the above cleaning.

In this example, the chemical-mechanical polishing rate become twice that obtained in the case of using the related art silica base slurry. The shape of the planarized film was also excellent.

Example 2

In this example, a metal film formed on an interlayer dielectric film so as to bury openings connected to an Al interconnection layer is subjected to chemical-mechanical polishing using the abrasive particles mainly made of sialon. As shown in Fig. 2A, a first interlayer dielectric film 202 made of silicon oxide and an Al interconnection layer 203 were formed on a semiconductor substrate 201 made of silicon; a second interlayer dielectric film 204 was formed thereon; and openings 205

were formed in the second interlayer film 204 and buried with a blanket tungsten 206. These were all formed by known processes.

The blanket tungsten 206 was subjected to chemical-mechanical polishing under the following condition using the polishing apparatus shown in Fig. 3.

| | |
|---|---|
| rotational speed of polishing plate: | 50 rpm |
| rotational speed of carrier | : 17 rpm |
| polishing pressure | : 10 psi |
| temperature of polishing pad | : 30-40℃ |
| flow rate of slurry | : 225 ml/min |

The polishing condition is that generally used for films. Here, for the purpose of polishing in an acidic atmosphere, a suspension in which a slurry containing abrasive particles mainly made of sialon was suspended in a solution of dilute hydrofluoric acid/water/alcohol, was used as a polishing agent. The abrasive particles of sialon was formed in the same manner as that in Example 1.

As a result, the blanket tungsten 206 was planarized, as shown in Fig. 2B. Next, the residual slurry and contamination on the surface of the substrate were

removed by the spin cleaner using chemicals of $NH_4OH$-$H_2O_2$-$H_2O$ and dilute hydrofluoric acid in this order, and finally, the surface of the substrate was rinsed with pure water. The residual slurry and contamination were thus removed in a satisfactory level.

In this example, the chemical-mechanical polishing rate become 2.5 times that obtained in the case of using the related art silica base slurry. The planarized shape of the plug 207 was also excellent.

Example 3

In this example, an interlayer dielectric film formed on an Al interconnection layer is subjected to chemical-mechanical polishing using abrasive particles mainly made of boehmite (AlOOH). The shape of a substrate is the same as that used in Example 1 (Fig. 1).

Specifically, as shown in Fig. 1A, a first interlayer dielectric film 102 made of silicon oxide and an Al interconnection layer 103 were formed on a semiconductor substrate 101 made of silicon, and a second interlayer dielectric film 104 was formed thereon. In addition, these were all formed by known processes.

The second interlayer film 104 was then subjected

to chemical-mechanical polishing under the following condition using the polishing apparatus shown in Fig. 3.

| | |
|---|---|
| rotational speed of polishing plate: | 50 rpm |
| rotational speed of carrier | : 17 rpm |
| polishing pressure | : 8 psi |
| temperature of polishing pad | : 30-40℃ |
| flow rate of slurry | : 225 ml/min |

The above polishing condition is that generally used for dielectric films. Here, for the purpose of polishing in a basic atmosphere, a suspension in which a slurry containing abrasive particles mainly made of boehmite was suspended in a solution of KOH/water/alcohol, was used as a polishing agent. The abrasive particles of boehmite was formed by dipping of particles of Al in a hot water at 80℃. In addition, it is effective to add sodium aluminate to the hot water, as needed.

As a result, the second interlayer dielectric film 104 was planarized, as shown in Fig. 1B. Next, the residual slurry and contamination on the surface of the substrate were removed by the spin cleaner using chemicals of $NH_4OH$-$H_2O_2$-$H_2O$ and dilute hydrofluoric acid in this

order, and finally, the surface of the substrate was rinsed with pure water.

The residual slurry and contamination were thus removed in a satisfactory level. In particular, although contamination due to aluminum as a component of boehmite was a matter of concern, it was sufficiently removed by the above cleaning.

In this example, the chemical-mechanical polishing rate become 1.5 times that obtained in the case of using the related art silica base slurry. The shape of the planarized film was also excellent.

As described above, according to the present invention, at least one or more of thin films formed on a substrate are subjected to chemical-mechanical polishing using a slurry containing abrasive particles mainly made of sialon or boehmite.

The present invention thus makes it possible to realize a polishing rate very higher than that obtained in the related art using the silica base slurry, and hence to fabricate VLSIs or the like at high reliability and high productivity.

The present invention also makes it possible to sufficiently compensate for a reduction in focal depth with

the shortened wavelength of light in lithography because of improvement in planarity of interlayer dielectric films, and hence to keep the resolution already reaching a critical value.

In addition, it is to be understood that the present invention is not limited to the above-described specific examples, and the configuration, condition and the like may be suitably changed without departing the scope of the present invention. For example, the planarization for the tungsten plug can be performed using the boehmite base slurry.

WHAT IS CLAIMED IS:

1. A chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate, wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of sialon.

2. A chemical-mechanical polishing process according to claim 1, wherein the chemical-mechanical polishing using said slurry containing the abrasive particles mainly made of sialon is performed in a basic atmosphere.

3. A chemical-mechanical polishing process according to claim 2, wherein said basic atmosphere is formed using a suspension in which said slurry containing the abrasive particles mainly made of sialon is suspended in a solution of KOH/water/alcohol.

4. A chemical-mechanical polishing process according to claim 1, wherein the abrasive particles mainly made of sialon are formed from a gas system containing $SiH_4$, $N_2$, $O_2$, and $Al(CH_3)_3$ by plasma CVD.

5. A chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate, wherein said thin films are subjected to

chemical-mechanical polishing using a slurry containing abrasive particles mainly made of sialon, and the residual slurry and contamination are removed by spin cleaning.

6. A chemical-mechanical polishing process according to claim 5, wherein said spin cleaning is performed using chemicals comprising $NH_4OH$-$H_2O_2$-$H_2O$ and dilute hydrofluoric acid.

7. A chemical-mechanical polishing process according to claim 6, wherein after spin cleaning using said chemicals, said substrate is rinsed with pure water.

8. A chemical-mechanical polishing process according to claim 5, wherein the chemical-mechanical polishing using said slurry containing the abrasive particles mainly made of sialon is performed in a basic atmosphere.

9. A chemical-mechanical polishing process according to claim 8, wherein said basic atmosphere is formed using a suspension in which said slurry containing the abrasive particles mainly made of sialon is suspended in a solution of KOH/water/alcohol.

10. A chemical-mechanical polishing process according to claim 5, wherein the abrasive particles mainly made of sialon are formed from a gas system containing $SiH_4$, $N_2$, $O_2$, and $Al(CH_3)_3$ by plasma CVD.

11. A chemical-mechanical polishing process according to claim 5, wherein said slurry containing the abrasive particles mainly made of sialon is used for chemical-mechanical polishing of a tungsten film .

12. A chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate, wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of boehmite.

13. A chemical-mechanical polishing process according to claim 12, wherein the particles of boehmite are formed by dipping of particles of Al in a hot water.

14. A chemical-mechanical polishing process according to claim 13, wherein said hot water is added with sodium aluminate.

15. A chemical-mechanical polishing process for planarizing one or more of thin films formed on a substrate, wherein said chemical-mechanical polishing is performed using a slurry containing abrasive particles made of a material higher in hardness than $SiO_2$.

16. A chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate, wherein said thin films are subjected to

chemical-mechanical polishing using a slurry containing abrasive particles mainly made of boehmite, and the residual slurry and contamination are removed by spin cleaning.

17. A chemical-mechanical polishing process according to claim 16, wherein said spin cleaning is performed using chemicals comprising $NH_4OH$-$H_2O_2$-$H_2O$ and dilute hydrofluoric acid.

18. A chemical-mechanical polishing process according to claim 17, wherein after spin cleaning using said chemicals, said substrate is rinsed with pure water.

19. A chemical-mechanical polishing process according to claim 16, wherein the abrasive particles of boehmite are formed by dipping of particles of Al in a hot water.

20. A chemical-mechanical polishing process according to claim 19, wherein said hot water is added with sodium aluminate.

## ABSTRACT OF THE DISCLOSURE

A chemical-mechanical polishing process for planarizing at least one or more of thin films formed on a substrate, wherein the chemical-mechanical polishing is performed using a slurry containing abrasive particles mainly made of sialon or boehmite. This process is advantageous in improvement of a polishing rate without degradation in planarity of the processed surface and in level of metal impurities.

Attorney's Docket No.

## DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION
**English Language Declaration**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

CHEMICAL-MECHANICAL POLISHING PROCESS

the specification of which

(check one)

☒ is attached hereto.

☐ was filed on _____ as

Application Serial No. _____

and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

| Prior Foreign Application(s) | | | Priority Claimed | |
|---|---|---|---|---|
| P07-321005 (Number) | Japan (Country) | 14/11/95 (Day, Month, Year Filed) | ☒ Yes | ☐ No |
| _____ (Number) | _____ (Country) | _____ (Day, Month, Year Filed) | ☐ Yes | ☐ No |
| _____ (Number) | _____ (Country) | _____ (Day, Month, Year Filed) | ☐ Yes | ☐ No |

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

| (Application Serial No.) | (Filing Date) | (Status) (patented, pending, abandoned) |
|---|---|---|
| _____ | _____ | _____ |
| _____ | _____ | _____ |

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued theron.

Attorney's Docket No.

## English Language Declaration

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

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Second Inventor's signature — Date

Residence

Citizenship

Post Office Address

(Supply similar information and signature for third and subsequent joint inventors.)

FIG. 1A

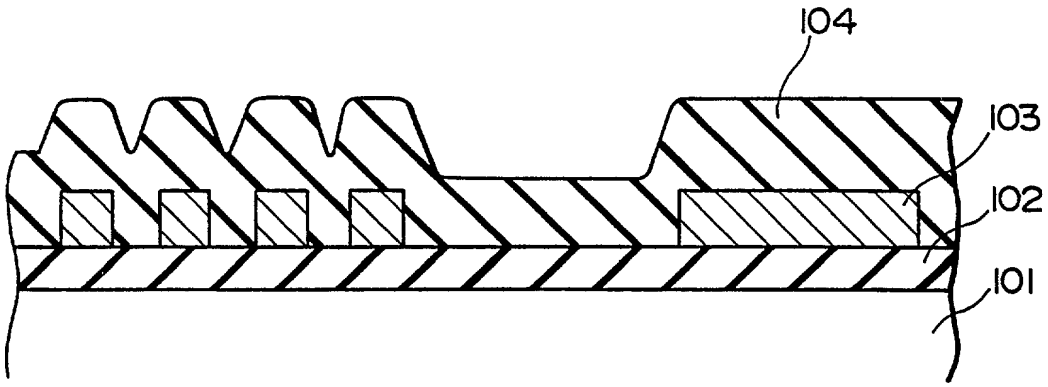


FIG. 1B

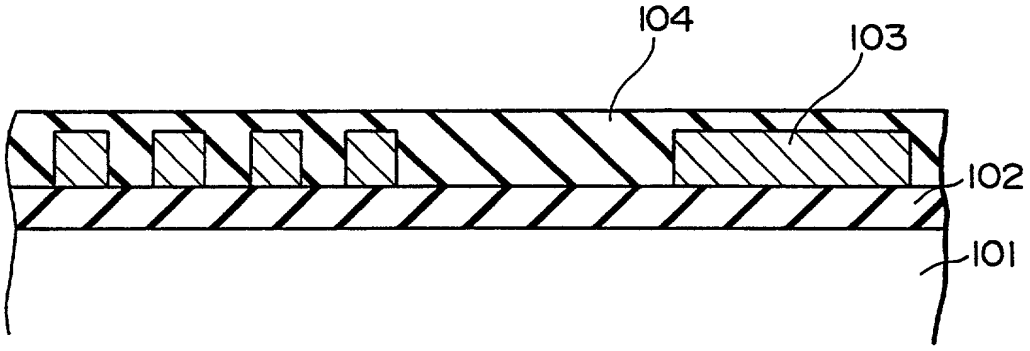

FIG. 2A

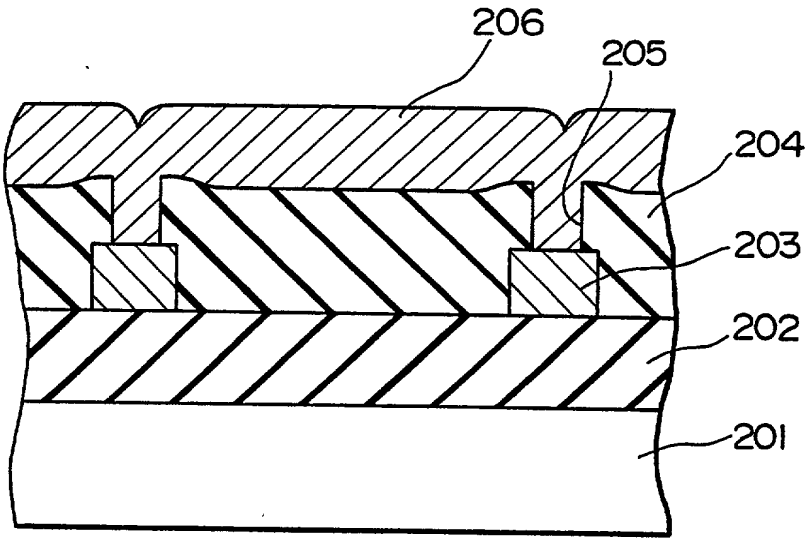


FIG. 2B

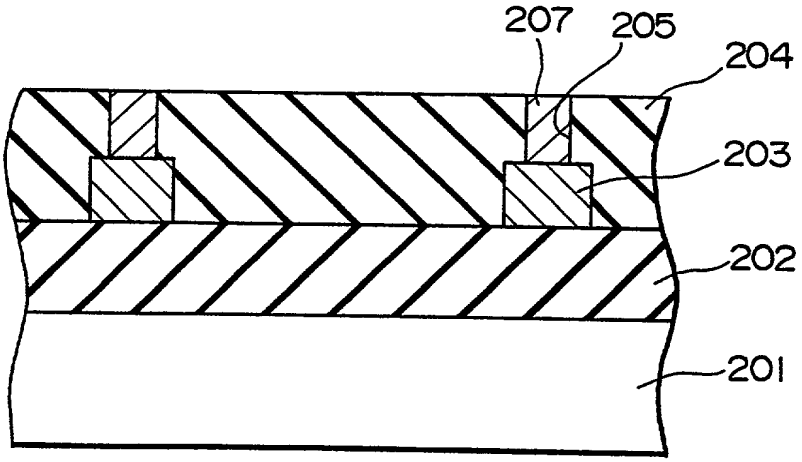

FIG. 3